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In Fig. 2 is shown a schematic circuit diagram of the Model 9-66 tube tester. This is the professional type tube tester. This circuit possesses several distinct advantages as will become apparent from the following explanation.

In the diagram, Ta is the tube under test. T₁ rectifies plate voltage. T₂ rectifies grid and screen voltages. The voltages E₁-E₂-E₃-E₄-E₅ are generated in windings on the same transformer and are consequently in phase.

Consider, first, conditions with grid signal voltage E₅ eliminated. During the half cycle that P₁ is positive, current flows P₁-K₂-S₁-Pa-K₁-B-D-r₁-e to P₁. A portion of the current is shunted through r₂ and the d'Arsonval meter M. The current through the meter flows from f to e and causes the meter to tend to deflect to the left. During the half cycle that P₂ is positive, current flows P₂-K₂-S₁-Pa-K₁-B-D-r₂-f-P₂. A portion of the current is shunted through r₁-M. The current through the meter flows from e to f causing it to tend to deflect to the right. But because of the inertia of the moving parts of the meter it cannot follow the rapid current alternations; the meter pointer is motionless.

Consider, first, conditions with the grid signal voltage E₅ effective. When P₁ is positive the point C is negative with respect to B. This makes the grid G more negative which reduces plate current. The shunted current through the meter from f to e is also reduced. When P₂ is positive the point C is positive with respect to B. This makes the grid less negative which increases plate current. The shunted current through the meter from e to f is increased.

The current now tending to push the meter pointer to the right is greater than the current pushing to the left, consequently the pointer moves to the right. This unbalance of current represents the mutual conductance of the tube Ta.

Thus the meter M can be calibrated in micromhos, the micromho being the unit of mutual conductance.

Mutual Conductance is Defined

$$\frac{\text{Change in plate current}}{\text{Change in grid volts}} = \text{Mutual Conductance}$$

Stark Model 9-66 operates upon the above basic formula or principle. It is calibrated from basic values in conformance with the above formula. No special tests are necessary to calibrate these testers since they actually measure micromhos. For example; with a signal volt of 1 volt applied to the grid 1 milliamperes of change or A.C. plate current represents 1000 micromhos, two milliamperes, 2000 micromhos etc. With 5 signal volts applied to the grid 5 milliamperes in the plate equals 1000 micromhos etc. In other words, Stark Model 9-66 is a basic device, the meter being calibrated as a milliammeter with the scale transposed or converted into micromhos.

A further advantage of the Stark Model 9-66 tube tester is high plate current modulation when testing output and other high plate current tubes. Fig. 3 shows a comparison between ordinary modulation and modulation in the Stark Model 9-66 tube tester. At A is shown ordinary modulation. The current peaks P are not high enough to reveal saturation at S. At B which shows modulation in the Stark Model 9-66, the peaks "m" are depressed and the peaks "n" are elevated due to the signal action on the grid as explained above. Due to saturation the peaks "n" are flattened at the top, while the peaks "m" are normal in shape. The reading of the Stark meter M is the difference in height between "m" and "n". The flattening of "n" therefore causes a lowered micromho reading which would not be detected by the modulation of A.

To give good results under all operating conditions a tube should operate with unimpaired efficiency at 100% modulation. The Stark Model 9-66 dynamic mutual conductance tube tester applies 100% modulation while measuring mutual conductance in micromhos.

In testing the internal characteristics of a vacuum tube it is undesirable to have conditions in the measuring instrument affect the results. Reactance in the plate circuit of the test instrument cause errors in readings. This applies to chokes and transformers which are sometimes used in connection with a copper oxide rectifier in the plate circuit of a tube tester. Such circuits cannot be calibrated in micromhos because the error is different for different tubes, depending upon the plate resistance of the tube in relation to the instrument resistance or reactance.

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